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THESIS

A PC-BASED MODEL
FOR ESTIMATING
REGIONAL RECRUIT MARKETS

by

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September 1992

Thesis Advisor: George W. Thomas

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A PC-BASED MODEL
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by

Adnan Bicaksiz
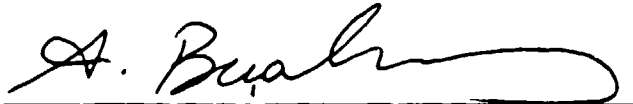First Lieutenant, Turkish Army
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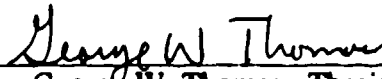## MASTER OF SCIENCE IN MANPOWER MANAGEMENT

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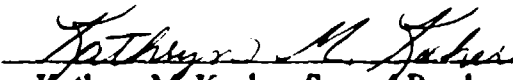## NAVAL POSTGRADUATE SCHOOL
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ABSTRACT

This thesis develops a personal-computer-based (PC-based) model to utilize research results for the estimation of male high quality (HQ) and high-tech (HITEC) qualified military available (QMA) population. HQ QMA are 17-21 year-old high school graduates scoring above the 50th percentile on the Armed Forces Qualification Test (AFQT). HITEC QMA are the HQ QMA who are mentally eligible for highly technical military occupations. Research underlying the PC-based model estimates multinomial logistic regression equations using the National Longitudinal Survey of Youth Labor Force Behavior (NLSY) data over a set of explanatory variables for which data are available at the county level. Using the PC-based model, nationwide county-level measures of regional male recruit markets by size and mental quality for 1990 through 2010 are estimated. The PC-based model and the nationwide market estimates may be useful in recruiting management decisions such as resource allocation and recruiter goaling.

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I. INTRODUCTION

Since the early 1980s, the Armed Services have been recruiting high quality (HQ) young people in increasing numbers. High quality recruits are high school graduates scoring above the 50th percentile on the Armed Forces Qualification Test (AFQT). The attribution of the victory in Operation Desert Storm (January-February 1991) to high quality personnel and training[1] signals the Armed Services' intention to continue their pursuit of HQ recruits. However, the recruiting success of the 1980s may not be achieved in the 1990s and onward. The projected decline in the size and quality of the youth population in the 1990s (Thomas and Kocher, 1991) poses a challenge to the Services in meeting their recruiting goals.

The planned reduction of 25 percent of the total force size by 1995 may alleviate the problem for the occupations that are not highly technical, while highly technical occupations may experience a shortage of suitable high quality (HQ) young people who are also in high demand by the civilian sector and colleges. Young people who qualify morally, medically, and mentally for highly technical occupations make

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[1] Jehn, Christopher, Assistant Secretary of Defense, Force Management and Personnel as quoted in Uslar, 1991.

up the "high-tech military recruit market", and this market is likely to be the focal point for the military recruiting process.

Another aspect of the problem is that interest in joining the military and qualifications to do so are not uniformly distributed over the geographic area of the United States (Thomas and Gorman, 1991). Some regions have larger numbers and higher proportions of the High Quality Qualified Military Available (HQ QMA) population than others. Hitec recruits who constitute the upper mental group of the HQ QMA population are not distributed uniformly, either. Knowing where the "pools" of hitec recruits are located and concentrating recruiting efforts on these people to attract them to the military rather than targeting all 17-21 year-olds is one good way to meet recruiting goals more cost effectively. Thus, recruiting success is dependent upon the accurate estimation of geographic variations in moral, medical, and mental qualification rates.

This thesis attempts to develop a PC-based model and a nationwide database that will provide at the county level the estimated numbers of qualified military available (QMA) population in these mental categories[2]:

1. CAT1: Hitec, i.e. AFQT I-IIIA and eligible for highly technical jobs.

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[2] Uslar (1991) defined these four mental categories.

2. CAT2: HQ-not-hitec, i.e. AFQT I-IIIA but not eligible for highly technical jobs.

3. CAT3: AFQT IIIB.

4. CAT4: AFQT IV-V.

Throughout this thesis, the term "resident youth population" (RES) will refer to all 17 to 21 year-olds living in a county. The "military available population" (MA) will denote 17-21 year-old high school graduates available to the military, i.e., not already in the military, or in other institutions like prisons, permanent health care facilities etc. The "qualified military available population" (QMA) will describe a segment of MA within a mental category. Thus, CAT1 QMA (or HITEC QMA) will refer to the portion of MA who mentally qualify for highly technical occupations. The HQ QMA population is the combination of the CAT1 QMA and CAT2 QMA.

Previous research by Thomas and Gorman (1991), Moreau (1991), and Uslar (1991) provides the basis for this thesis. They used the National Longitudinal Survey of Youth Labor Force Behavior (NLSY) data to estimate an individual's mental aptitude given his or her sociodemographic characteristics such as age, gender, race/ethnicity, parents' educational level, socioeconomic status, and region of residence. This thesis will build on their work to construct a PC-based model and a nationwide database with county level data. In the estimation process only demographic variables for which data are available at the county level will be used.

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The questions to be answered in this thesis are: (1) Can a PC-based model be developed for regional estimation of qualified military available population? (2) Can a nationwide database be developed for the same purpose? (3) How valid is the PC-based model?

The focus of interest will be on male 17-21 year-old high school graduates who can be called the "prime male recruit market". The Armed Services have had little difficulty in recruiting women in the past and are not expected to encounter the serious problems they are likely to find in recruiting males in the future. The models and procedures presented in this thesis, however, also c n be used for the estimation of the female recruit market.

II. LITERATURE REVIEW

The Armed Services draw their recruits primarily from the 17-21 age group of the youth population and, therefore, changes in the size and composition of the youth population have always been a concern to the military. In addition, the characteristics of the youth population, such as labor force participation rates, educational attainment, moral and physical properties, mental aptitude levels and career aspirations, are also of interest to the Services. Factors affecting military recruitment include the size and composition of the recruit market, the technological scope of military occupations, techniques of mental aptitude testing and predictors of mental ability. The knowledge of these factors enables manpower planners and recruiters to locate potential recruits. The following sections provide background information about these factors.

A. POPULATION TRENDS AND SHRINKING RECRUIT MARKETS

Thomas and Kocher (1991), in their recent work on youth labor force dynamics, have forecast a decline in the size and quality of the youth labor force and changes in its racial distribution. Declining fertility and birth rates and the compensating effects of immigration have brought about slow population growth in the U.S. in this century. As the low

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growth rate of the total population is expected to continue, the size of the youth (ages 16-24) population and its share in the total U.S. population are expected to decline in the future. As shown in Table I, the youth population size is forecast to decrease until 1995, then start to increase slowly through 2010, and then decrease again through 2080. The share of the youth population in the total population will go down to 8.1 percent in 2080, from 10.3 percent in 1990. Consequently, the median age of the total population will increase from 33 years in 1990 to 42.8 years in 2080. This trend will be accompanied by a change in the racial mix of the youth population. Nonwhites who make up 15.6 percent of the total population and 17.9 percent of the youth population in 1990 will grow gradually to account for 25.5 and 25.1 percent of the total and youth populations, respectively, in 2080 (Thomas and Kocher, 1991).

A decline in the quality as well as in the quantity of the future youth labor force is expected. Recent downward trends in high school completion rates, college enrollment rates, and achievement levels (based on such indicators as NAEP proficiency measures, SAT and ACT scores[3]) indicate that the overall quality of the youth labor force will decline. Minority youth, who have historically had lower achievement

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[3] NAEP: National Assessment of Educational Program.
SAT: Scholastic Aptitude Test.
ACT: American College Testing Program Assessment.

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levels, will have limited skills on entering the labor market
(Thomas and Kocher, 1991).

Table I. SIZE AND RACIAL DISTRIBUTION OF YOUTH (AGE 18-24)
POPULATION AND MEDIAN AGE OF TOTAL POPULATION, PROJECTIONS
TO 2080

Year	Youth Pop Size 000,000	Percent Youth, Total Pop	Percent Nonwhite, Total Pop	Percent Nonwhite, Youth Pop	Median Age Total Pop (years)
1990	25.8	10.3	15.6	17.9	33.0
1995	23.7	9.1	----	----	----
2000	24.6	9.2	16.9	18.7	36.3
2010	27.7	9.8	18.3	19.5	38.4
2030	26.2	8.6	20.7	20.6	40.8
2050	25.7	8.3	23.0	23.5	41.6
2080	25.3	8.1	25.5	25.1	42.8

Source: Based on the middles series (moderate)
estimates of Tables II-3, II-4, and II-5 in Thomas and
Kocher, 1991, pp. 26-28.

As the quality and the quantity of the youth population
decline, the portion of the youth population who are qualified
for military service will also be smaller in the future. Also
of interest to the military is the geographical variation in
mental, medical, and moral qualification rates of the youth
population to join the Services (Thomas and Gorman, 1991).
This variation is expected to become more pronounced due to
differential regional population growth rates. This will

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require military recruiting efforts to be concentrated in regions with higher numbers of potential recruits.

B. TECHNOLOGY AND CLASSIFICATION OF MILITARY OCCUPATIONS[4]

Advances in technology have often been driven by the demands of national defense. As technology has created more complicated equipment and new techniques for fighting a war, the skill requirements of military personnel have increased considerably. This has led to the emergence of today's highly specialized, highly technical military occupations which often require long and costly training for personnel assigned to them. In Eitelberg's (1988) words:

> Recruits who used to be assigned to general combat duty are now working at jobs such as ADP Computer Programmer, Crypto Equipment Systems Specialist, and Naval LHA Integrated Tactical Amphibious Warfare Data Systems Maintenance Technician.

Table II gives a chronological overview of how occupations in the U.S. military have changed over time. During the American Civil War, 93.2 percent of male enlisted personnel were assigned to general combat duties. After about half a century, only 41.8 percent of personnel were in that category. This trend toward occupational specialization gave birth to the first "Index of Occupations" in the Army for classifying new recruits and setting manpower goals. The trend continued.

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[4] This section draws mostly from Eitelberg, 1988, pp.3-12.

following World War I. By the end of World War II, the number of occupational specialties climbed to 532 in the Army, 74 in the Navy, and 369 in the Marine Corps. This process has slowed down after 1960. As shown in Table II, changes in the occupational distribution since 1960 have been smaller than those in the 1865-1960 period (Eitelberg, 1988).

Table II. PERCENTAGE DISTRIBUTION OF MALE ENLISTED PERSONNEL, ALL SERVICES, BY MAJOR OCCUPATIONAL CATEGORY, 1865-19⁴⁴

Major Occupational Category	Civil War[a] 1865	World War I[b] 1918	World War II 1945	Peace-time Draft 1960	All-Volunteer Force 1984
WHITE COLLAR	0.9	11.9	25.2	39.4	44.0
Technical	0.2	6.8	11.6	20.0	28.9
Clerical	0.7	5.1	13.6	19.4	15.1
BLUE COLLAR	99.1	88.1	74.7	60.6	56.0
Craftsmen	0.6	21.6	25.9	30.3	28.1
Service and Supply	5.3	24.7	14.8	11.6	10.5
General Military Skills	93.2	41.8	34.0	18.7	17.4
TOTAL	100.0	100.0	100.0	100.0	100.0

Source: Based on Table 1 in Eitelberg, 1988, p. 12.
[a] Based on the Union Army only.
[b] Includes Army and regular Navy personnel only.

At present, the Department of Defense occupational classification system contains 10 occupational areas (including a "nonoccupational" category for trainees, students, prisoners, and others). Within these 10 occupational

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areas for enlisted personnel are 68 occupational groups; and within the 68 occupational groups are another 160 subgroups. The Military Services themselves each have their own system for categorizing enlisted occupations. There are a total of about 2,250 separate titles for enlisted occupations used by the Services (Eitelberg, 1988).

C. MENTAL APTITUDE TESTING IN THE U.S. MILITARY

The use of objective tests to select a number of employees (or recruits) from a larger pool of applicants is justified by studies that uniformly show that objective test procedures for employee selection are more economical and superior to the traditional alternative--discretionary judgments based on an interview, references, and possibly school grades[5].

The U.S. Military Services currently use the Armed Services Vocational Aptitude Battery (ASVAB), the most widely used multiple aptitude battery and the largest-volume employment test in the United States. The ASVAB is a paper-and-pencil test and contains 10 independently timed and scored subtests, as shown in Table III. It was installed in 1976 as the Defense-wide test for recruit screening and job assignment. Its predecessors were Army Alpha and Army Beta

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[5] Bock and Moore (1984) refer to <u>Appraising Vocational Fitness by Means of Psychological Tests</u> by Super and Critas (1962).

during 1917-1918, and the Army General Classification Test

(AGCT) during World War II (Eitelberg, 1988).

Table III. ASVAB SUBTESTS: DESCRIPTION, NUMBER OF
QUESTIONS AND TESTING TIME

ASVAB Subtest Title and Abbreviation		Description of Subtest Content	Time (min)/ Quest-ions
General Science	GS	Physics, biology	11/25
Arithmetic Reasoning	AR	Arithmetic problems	36/30
Word Knowledge	WK	Meaning of words	11/35
Paragraph Comprehension	PC	Obtain written info.	13/15
Numerical Operations	NO	Arithmetic speed	3/50
Coding Speed	CS	Coding words,numbers	7/84
Auto & Shop Info.	AS	Knowledge about cars	11/25
Mathematics Knowledge	MK	High school math.	24/25
Mechanical Comprehension	MC	Physical principles	19/25
Electronics Info.	EI	Electricity & electronics	9/20

Source: Based on Table 16 in Eitelberg, 1988, p. 68.

The Services combine scores of several ASVAB subtests to

form "composites." These composites are used for screening

recruits and/or assigning them to occupational specialties.

One composite used by all the Services primarily for screening

is the Armed Forces Qualification Test (AFQT). Table IV gives

ASVAB composites and component subtests for the Navy.

All the Services use the AFQT composite for screening,

however they convert raw scores into percentile scores and

Table IV. TITLES, ABBREVIATIONS AND COMPONENT SUBTESTS OF NAVY ASVAB CLASSIFICATION COMPOSITES

Title	Abbrev-iation	Composite Subtests[a]
General Technical	GT	AR+VE
Mechanical	MECH	AS+MC+VE
Electronics	ELEC	GS+AR+MK+E
Clerical	CLER	NO+CS+VE
Aviation Structural Mechanic	AM	MC+VE
Basic Electricity/Electronics	BE/E	GS+AR+2MK
Boiler Technician/ Engineman/Machinist's Mate	BT/ EN/MM	AS+MK
Machinery Repairman	MR	AR+AS+MC
Submarine	SUB	AR+MC+VE
Communications Technician	CT	AR+NO+CS+VE
Hospitalman	HM	GS+MK+VE

Source: Based on tables 17 and 18 in Eitelberg, 1988, pp. 70 and 72.
[a] VE is and abbreviation for the Verbal composite, a combination of the Word Knowledge (WK) and Paragraph Comprehension (PC) subtests.

form five AFQT categories that indicate the recruit's level of trainability (see Table V). The AFQT composite, for all branches of the Armed Forces, is made up of:

$$AFQT= 2VE + AR + MK$$

D. DETERMINANTS OF MENTAL ABILITY

The most heated topic in the field of psychological testing is perhaps the "nature versus nurture" debate on what factors determine one's mental ability. Proponents of the 'nature' side argue that genes are dominant factors; thus,

Table V. AFQT CATEGORIES BY CORRESPONDING PERCENTILE
SCORES AND LEVEL OF TRAINABILITY

AFQT Category	AFQT Percentile Score	Level of Trainability
I	93-99	Well above average
II	65-92	Above average
IIIA	50-64	Average
IIIB	31-49	Average
IV	10-30	Below average
V	1-9	Well below average

Source: Eitelberg, 1988, p.74.

mental ability is predominantly hereditary. On the other hand, one's aptitude level is attributed primarily to environmental factors by proponents of the 'nurture' side[6].

The person who set the stage for this debate was Alfred Binet, the creator of the first test of mental ability in 1905. He believed that one's intelligence could be developed by practice, enthusiasm, and method (Peterson, 1990).

Almost a century after Binet the debate is still far from over. However, both sides have come to recognize the effects of sociodemographic factors such as race, gender, age, educational attainment, geographic region, and socioeconomic status on mental ability.

The "Profile of American Youth", a 1980 study sponsored by the Department of Defense, provided insight into the effects

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[6] For a bibliography of selected material representing each side, the interested reader may refer to Eitelberg, 1981.

of sociodemographic factors on one's mental aptitude. In the study, the ASVAB was administered to a nationally representative sample of 11,914 youths ages 15 to 23. This sample was drawn from the National Longitudinal Survey of Youth Labor Force Behavior (NLSY) which had 12,686 respondents under study . Bock and Moore (1984) analyzed respondents' test results on the basis of individual subtest scores for subgroups by age, gender, sociocultural group, educational level, economic status, region of residence, and mother's education. Another analysis was conducted by the Department of Defense on the basis of AFQT percentile scores[7]. The following subsections give a summary and comparison of the findings of two analyses on the bases of individual subtest scores and AFQT separately.

1. Age

Performance on tests such as Arithmetic Reasoning and Numerical Operations, representing intensive, school-learned skills declined after the completion of formal schooling. Performance on test content that is learned by experience, such as Auto and Shop Information and Electronics Information improved after leaving school. Overall, effects were small and

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[7] Department of Defense, <u>Profile of American Youth:</u> <u>1980 Nationwide Administration of the Armed Services</u> <u>Vocational Aptitude Battery</u>, Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics), Washington, DC, 1982.

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performance on all tests remained nearly at the level at the end of schooling.

On the other hand, AFQT percentile scores improved with age. The age group of 18-19 years scored a mean of 46, while 20-21 and 22-23 year groups scored 50 and 54 respectively.

2. Gender

Men and women differed most in knowledge of topics that are traditionally specialized by gender. Women excelled in Coding Speed, Numerical Operations, and Paragraph Comprehension, while men generally exceeded women in General Science, Arithmetic Reasoning, Mechanical Comprehension, Electrical Information, and Auto and Shop Information. No sex difference was observed in Word Knowledge and Mathematics Knowledge. On the AFQT percentile scores, both sexes performed similarly.

3. Sociocultural Group (race/ethnicity)

For all tests, Whites had the highest scores, Hispanics were intermediate but somewhat closer to Whites, and Blacks consistently scored lowest. (Bock and Moore, (1984) cautioned here that these findings could not be interpreted as the inferiority of Black genes nor the superiority of White genes. They cited (pp.161-163) studies which found that Black children adopted by White families performed at levels comparable to their White peers in tests of mental ability).

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AFQT percentile scores followed the same pattern, with mean scores of 56 for Whites, 31 for Hispanics, and 24 for Blacks.

4. Educational Level

Generally, p. .ormance on tests improved with years of schooling and specifically, educational effects were strongest for tests that measure school-intensive knowledge and skills such as Arithmetic Reasoning, and Mathematics Knowledge.

AFQT percentile scores showed a clear relationship to the level of education as non-high school graduates scored a mean of 27, GED (General Educational Development high school equivalency) recipients scored 46, and high school diploma graduates scored 57.

5. Socioeconomic Status

The nonpoor (those above the officially defined poverty level) scored higher on the tests than their poor counterparts (at or below poverty level)[8].

In the AFQT-based analysis, mother's education was used as an approximation to socioeconomic status. It was found that mean AFQT percentile scores improved with mother's education. Subjects whose mothers completed 8th grade or less

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[8] Poverty level for nonfarm families living in the continental United States is defined as a net 1979 family income less than or equal to $3,770 ($3,220 for farm) plus $1,230 ($1,040 for farm) times ¬ne less th¬., the number of persons in the family unit (Bock and Moore, 1984).

scored a mean of 29, 9th to 11th grades 38, high school 54, some college 63, and college graduate and more 71.

6. Region of Residence

There were small but readily interpretable regional differences in ASVAB test performance. Performance of Blacks and Whites tended to be highest in the Northeast, next highest in the Midwest and West, and lowest in the Southeast. Hispanics followed a converse pattern, with highest levels of performance in the Southeast and Midwest, and lower levels in the East and West.

AFQT analysis, done without regard to sociocultural group effects, shoʷd that mean percentile scores were highest in the Northeas₊ (58-60) and lowest in the South (42-44).

7. Mother's Education

Mother's education showed a strong and direct association with test performance, especially in those tests which depend upon language and instruction (Word Knowledge, Paragraph Comprehension, General Science, Arithmetic Reasoning, and Mathematics Knowledge).

AFQT percentile scores improved substantially with mother's education as mentioned above under socioeconomic status.

E. ESTIMATING ELIGIBILITY FOR HITEC MILITARY OCCUPATIONS

1. Pioneer Studies

Research on test performance on the AFQT and the development of estimating equations for regional QMA have been pioneered in a research program at the Naval Postgraduate School. Studies by Peterson (1990), Thomas and Gorman (1991), Rickman (1991), Moreau (1991), and Uslar (1991) are noteworthy.

Using the NLSY data, Peterson (1990) estimated the probability that a 17-21 year-old high school graduate will score above the 50th percentile on the AFQT, given sociodemographic factors such as gender, race/ethnicity, parents' education, poverty status, income, residence in an urban area, and receipt of welfare payments. His work is an important step in developing regional estimates of HQ recruits, and forming a nationwide database at the county level.

Thomas and Gorman (1991) also used the NLSY data to estimate the mean AFQT score for six race/gender subgroups using parents' education and its square, poverty status, and age as explanatory variables. This study targeted the estimation of HQ recruits at the county level, and, therefore, only the variables for which data were available at the county level were included.

Rickman (1991) did work similar to Peterson's (1990), but he used data from the Youth Attitude Tracking Study (YATS) and an expanded set of explanatory variables.

2. Estimating Hitec Recruits

The three studies above examined whether a young person could mentally qualify for military service (i.e., score above the 50th percentile on the AFQT) given his or her background characteristics. More recent studies by Moreau (1991) and Uslar (1991) focused on qualifying for highly technical military occupations which required better test performance than that required for the basic acceptance level. These two studies provided the basis for this thesis.

Moreau's work (1991) was arguably the first one that specifically focused on hitec recruits. With the NLSY data, Moreau (1991) used binomial logistic regression equations to estimate the probability that (1) one would qualify for hitec ratings, or (2) not; given his or her background characteristics. Uslar (1991) expanded Moreau's work basically in two ways: (1) he estimated the interest of hitec recruits in joining the military, and (2) he defined four mental categories instead of Moreau's two (hitec versus not hitec), thus, he used the multinomial logit instead of the binomial logit in the estimation process. The Navy, Uslar (1991) noted, was the only service which differentiated occupations into three general categories: (1) semitechnical, the least

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technical category which employed about one third of all enlisted personnel; (2) technical, the intermediate group where 47 percent of enlisted personnel were employed; and (3) highly technical, to which 20 percent of enlisted personnel were assigned. The problem of identifying specific hitec ratings was solved by the Defense Manpower Data Center (DMDC)[9]. Based on the data from the DMDC, Uslar constructed two tables out of which Table VI was formed. In Table VI are the Navy's highly technical rating groups and corresponding ASVAB subtests and cutscores required to qualify for these ratings. Using the NLSY data, Uslar estimated the probabilities of four mental category outcomes: (1) Hitec, (2) HQ-not-hitec, (3) AFQT IIIB, and (4) AFQT IV-V, given sociodemographic factors. Uslar's definition of mental categories will be retained in this thesis and the number of young people who fall into each category at present and in the future will be estimated.

This thesis will build on Moreau's (1991) and Uslar's (1991) work and expand it to develop a PC-based model that will be used to construct a nationwide county-level database for estimates of the male military available youth population categorized by mental aptitude.

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[9] Uslar (1991) notes the data provided by the Department of Defense, Manpower Data Center (DMDC), East, 4th Floor, 1600 N. Wilson Boulevard, Arlington, VA, 22209-2593, letter to Prof. George W. Thomas, 06/30/1991.

Table VI. NAVY HIGHLY TECHNICAL RATING GROUPS: REQUIRED
ASVAB SUBTESTS AND CUTSCORES, AND GROUP SIZES AS
PERCENTAGE OF TOTAL NAVY ENLISTED PERSONNEL

High Tech Rating Group	Number of High Tech Ratings in Group	Required ASVAB Subtests and Cutscores	Percent Enlisted Personnel in Group
I	8	MK+EI+GS=156 and MK+EI+GS+AR=218	11.7
II	6	2MK+AR+GS=196-214	6.8
III	4	AR+MK+GS+EI=204	2.5
IV	1	VE+AR+NO+CS=202	0.26

Source: Based on Tables 7 and 8 in Uslar, 1991, pp. 17-18.
Note: A list of the Navy highly technical ratings is provided in Appendix A.

III. METHODOLOGY AND PRESENTATION OF THE DATA

A. THEORETICAL FRAMEWORK

This thesis involves the use of parameters of multinomial logistic regression equations that are designed to estimate the mental group outcome probabilities given sociodemographic variables. The regression equations are estimated using a mainframe computer statistical analysis software package. The estimated parameters are then transferred to a spreadsheet program on a personal computer (PC) and used to estimate the number of people in each mental category for each county.

1. Mainframe Model

The ongoing (as of September, 1992) research by Thomas and Kocher at the Naval Postgraduate School provided parameter estimates to be used for the PC-based model. The NLSY data were used for these estimates. The NLSY contained data collected by the National Opinion Research Center (NORC) from 1979 to 1987 to study the labor force behavior of young people. The NLSY was fielded to a nationally representative sample of 12,686 respondents 15 to 23 years of ages at all educational levels. In 1980, under the sponsorship of the Department of Defense, the ASVAB was administered to about 94 percent (11,914) of the original NLSY sample to develop updated norms for the ASVAB. This additional study, called the

'Profile of American Youth', provided insight into the relationship between mental aptitude and background characteristics. To represent the 'prime military recruit market' properly, the sample was restricted to high school graduates ages 17-21. Table VII compares the original NLSY sample and the 'prime market sample' used in this study.

Table VII. DISTRIBUTION OF ORIGINAL NLSY SAMPLE AND PRIME MARKET SAMPLE BY GENDER AND RACE

Race/Gender Group	Original NLSY Sample Ages 15-23, all educational levels	Prime Market Sample Ages 17-21, high school graduates
White Males WM	3,790	1,438
Black Males BM	1,613	538
Hispanic Males HM	1,000	267
White Females WF	3,720	1,654
Black Females BF	1,561	644
Hisp. Females HF	1,002	295
TOTAL	12,686	4,836

Source: NLSY handbook, 1990.

The analysis by Bock and Moore (1984) of test performance and background characteristics of the 11,914 NLSY respondents who took the ASVAB provided results (as discussed in Ch.II-d) that facilitated the selection of explanatory variables for the model. However, only the variables for which the data were available at the county level were included in the model developed here. These variables were:

- **(SES)** Socioeconomic status: 1=poor, 0=nonpoor.

- **(PED)** Parents' education: average of both parents' years of education if available, otherwise that of one.

- **(PED2)** Parents' education squared.

- **(SW)** South-West: 1 if region of residence is in the Southeast or West[10], 0 if not.

Being a minority group member (Black or Hispanic) was expected to have a negative impact on one's mental category outcome. Poor or South-West residents, who had lower test scores than the nonpoor or those not residing in the South-West as discussed in Ch.II.d, were expected to have lower chances of qualifying for the highest mental category. On the other hand, since test scores improved with years of schooling of respondent's parents, the variables parents' education and its quare were expected to have a positive impact on one's mental category outcome.

The ordered multinomial logit model was used to estimate the probability that an individual would fall into any of the following four mental categories given his background characteristics:

- **CAT1 (Hitec)**: AFQT I-IIIA (above the AFQT 50th percentile) and eligible for highly technical occupations.

- **CAT2 (HQ-not-hitec)**: AFQT I-IIIA but not eligible for highly technical jobs.

- **CAT3**: AFQT IIIB (between the AFQT 31th and 49th percentiles).

- **CAT4**: AFQT IV-V (below the AFQT 30th percentile).

The ordered multinomial logit model, used to estimate mental group distributions, is based on the logit function:

$$g(P) = \log [P/(1-P)]$$

which is the inverse of the cumulative logistic distribution given by:

$$F(X) = 1/(1+e^{-X}).$$

Suppose Y_i can take on ordered values $1,\ldots,m$ where m is an integer greater than 1. Then P_{ij}, the probability that the ith individual has made choice j given the vector of personal characteristics $\mathbf{X}_i$, is

$$P_{ij} = P(Y_i=j|\mathbf{X}_i) = \begin{cases} F(\alpha_1 + \mathbf{b}'\mathbf{X}_i) & \text{for } j=1 \\ F(\alpha_j + \mathbf{b}'\mathbf{X}_i) - F(\alpha_{j-1} + \mathbf{b}'\mathbf{X}_i) & \text{for } 1<j<m \\ 1-F(\alpha_{m-1} + \mathbf{b}'\mathbf{X}_i) & \text{for } j=m \end{cases}$$

Six separate models (WM, BM, HM, WF, BF, HF) were estimated using the LOGISTIC procedure of Statistical Analysis Software (SAS) Version 6.06. Since this thesis focused on the "prime male recruit market", only the results of male models were presented and discussed here. The estimated coefficients for male models, shown in Table VIII, indicated that race, socioeconomic status, parents' education and region of residence had a significant impact on an individual's mental

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category outcome. White males were more likely to qualify for the hitec category than Hispanic males, and Hispanics were more likely to do so than Black males.

Table VIII. ESTIMATED COEFFICIENTS OF MODELS FOR MALES BY RACE

Variable	Parameter Estimate for WM Model n=1,438	Parameter Estimate for BM Model n=538	Parameter Estimate for HM Model n=267
Intercept1	-2.5896 (.01)	-4.1867 (.01)	-1.6777 (.01)
Intercept2	-1.8053 (.01)	-2.8597 (.06)	-0.7197 (.21)
Intercept3	-0.8184 (.23)	-1.8936 (.21)	0.2393 (.68)
SES	-0.3599 (.02)	-0.7653 (.01)	-0.6754 (.03)
SW	-0.2822 (.01)	-0.5349 (.01)	0.0926 (.73)
PED	0.1718 (.10)	0.0527 (.82)	-0.1317 (.23)
PED2	0.0023 (.56)	0.0080 (.39)	0.0126 (.02)

Source: Thomas and Kocher, 1992, unpublished research results.
Note: Numbers in parentheses denote Pr > Chi-Square.

Being poor significantly reduced the likelihood of qualifying for the hitec category for all races. Living in the 'South-West' states had a significant negative impact on mental category outcome for Whites and Blacks, but not for Hispanics. Since Hispanics predominantly lived in the South-West, the variable SW was not significant for the Hispanic male model. Varying significance levels of parents' education and its square showed that individual effects of these

variables were not significant, except the square of parents education for Hispanics.

Values for the explanatory variables SES, SW, and PED were derived as weighted national averages from Woods and Poole 1990 population estimates. The Woods & Poole data are presented in detail in Ch.III.b.1. The explanatory variable values, as shown in Table IX, were used to estimate the mental category distribution of the total MA population.

Table IX. EXPLANATORY VARIABLE VALUES FOR ESTIMATING MENTAL CATEGORY DISTRIBUTIONS OF MALE 17-21 YEAR-OLD HIGH SCHOOL GRADUATES

Sociocultural Group	PED (years)	SES (% in poverty)	SW (% pop in South-West)
WHITE n=3,587,232	12.1	9.0	50.2
BLACK n= 476,417	10.6	27.6	57.7
HISPANIC n= 386,468	9.5	22.9	74.5
TOTAL n=4,450,117	11.6	13.1	53.8

Source: Values are the weighted averages for all 3,074 counties in the continental U.S. (CONUS), and extracted from the W&P 1990 population estimates.

Mental category distributions by race for the 1990 male 17-21 year-old high school graduate population were determined by using the parameter estimates from the mainframe logistic regression model as shown in Table VIII, and values for sociodemographic characteristics, as shown in Table IX

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above. The distributions, as presented in Table X, showed that 41.2 percent of Whites were in CAT1, and thus would qualify for highly technical occupations. Hispanics followed with 13.2 percent, and Blacks with 3.8 percent. A similar rank order among races was observed in CAT2, but differences between races were smaller in CAT2 than in CAT1.

Table X. MENTAL CATEGORY DISTRIBUTIONS OF MALE 17-21 YEAR-OLD HIGH SCHOOL GRADUATES BY RACE

Socio-cultural Group	CAT1 %	CAT2 %	CAT3 %	CAT4 %	Total %
WHITE n=3,587,232	41.2	19.4	19.9	19.5	100.0
BLACK n= 476,417	3.8	9.1	15.0	72.1	100.0
HISPANIC n= 386,468	13.2	15._	22.5	49.1	100.0
TOTAL n=4,450,117	35.6	17.8	19.3	27.3	100.0

Note: Mental category distributions were calculated using estimated coefficients in Table VIII and variable values in Table IX.

On the negative side, about three quarters of the Black youth and half of the Hispanic youth fell into CAT4, a category from which the Services prefer not to recruit. Only about one fifth of Whites were in this category.

2. PC-based Model

The PC-based model uses the parameter estimates presented in Table VIII and county-level input data in a commercially available spreadsheet software package (Quattro Pro Version 4.0). Processing these parameter estimates with county-level population estimates yields a nationwide county-level database which contains the estimated number of people in each county in each mental category for selected race/gender groups. The spreadsheet is designed to provide the following information for each county:

- County identification: FIPS code, county name.
- Demographic statistics by race: Resident youth population, military available population, parents' educational level, proportion of population in poverty.
- Mental category distributions by race.

Two important assumptions are made in the estimation process using the PC-based model: (1) The Navy's hitec eligibility criteria (as presented in Table VI) are assumed valid for other Services, and (2) the effects of the explanatory variables used to estimate mental category outcomes are assumed constant over time. These assumptions, however, can be relaxed when (1) each Service determines its own criteria for high tech eligibility, and (2) updated sociodemographic study data become available in the future. The inclu.ion of new information on hitec eligibility criteria

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and population is expected to enhance the applicability of the PC-based model.

B. DATA SOURCES

1. Population Estimates (POPEST)

Population estimates (POPEST) provided by Woods and Poole Economics, Inc (W&P) were used in the PC-based model to estimate military available population by mental category for each county. The datafile resulting from this procedure contained the estimated number of people in each mental category and was labeled 'Category Estimates' (CATEST). The original W&P data contained estimates of specific population subsets (total, institutional, resident population, and college enrollment) for ages 17-29 by gender (male, female), race (White, Black, and Hispanic)[11], educational level (years of schooling), and socioeconomic status (proportion in poverty) for all 3,074 counties in the continental U.S. (CONUS) for years 1990, 1995, 2000, 2005, and 2010. For the purposes of this thesis, only 17-21 year-old males were selected and labeled as 'resident population'. Then, the population serving in the military, the institutional (in prisons, under permanent health care etc.) population, and those who were not high school graduates were subtracted from

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[11] Thomas and Gorman (1991), reconstructed the-not-mutually-exclusive White, Black, and Hispanic populations as three mutually exclusive groups. For details, refer to Appendix A in Thomas and Gorman (1991).

the resident population to obtain the 'military available population'. Male 17-21 year-old high school graduates were selected because they constitute the 'prime male recruit market'.

The educational level of people ages 25 or more were used as a proxy for the parents' education (PED) because the W&P data included years of schooling for people ages 17-29, but not for their parents.

The proportion of people in poverty was given for each sociocultural group for each county in the W&P data and used as the input value for socioeconomic status (SES) variable.

The South-West (SW) counties, not provided in the W&P data, were determined as those in the states listed in footnote 10 (Ch III-a.1) except states not in CONUS (Alaska (AK), Hawaii (HI), and Pacific Trust and Territories).

2. Actual Accessions (ACTAC)

Data on actual accessions (ACTAC) in 1990 were derived from the 1990 Active Duty Military Inventory (ADMI) Master File provided by the DMDC. The ADMI file contained personal information for those who entered the Military Services during 1990. Only the information fields relevant to this study were extracted from the ADMI file. These were gender, race, date of birth, region of residence, high school graduation status, ASVAB subtest scores and branch of service. ASVAB subtest scores for each individual were processed to determine mental

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category. Personal information was then aggregated at the county level to form the 'Actual Accessions' dataset (ACTAC) which contained county identification and 17-21 year-old male high school graduate accessions by race, mental category and branch of service for 3,047 CONUS counties. The ACTAC was used for assessing the validity of the PC-based model.

C. VALIDATION

1. Internal Consistency

A test for the internal consistency of the model involved the examination of market shrinkage patterns in the estimated data for individual counties to see whether those patterns reflected the anticipated effects of the explanatory variables. The proportion of poor people and years of parents' education were different for sociocultural groups for each count. Combined with the effect of being a 'South-West' county or not, variation in socioeconomic status and parents' education would render differential market shrinkage patterns for each county. These patterns should be consistent with the effects of the variables included in the estimation procedure. For example, if two South-West counties having identical population size and similar parents' education but differential proportion of people below the poverty line were compared, the county that had the higher proportion of people below the poverty line was expected to have a smaller number of people in the top mental category (hitec).

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2. External Consistency

A test for the external consistency of the m del was conducted by examining the correlation between the e. r mated number of people in each mental category and the actual number of people who were recruited and were qualified for the described mental categories for each county. The correlation coefficient was expected to be positive but less than one. Both the mainframe model and the PC-based model dealt only with qualification for military service and specific jobs within the military. Actual joining behavior, however, is a function of not only qualification to join the military but also of interest to do so, and of recruiting effort. Regional variation in interest in joining the military would therefore cause the coefficient of correlation between estimated and actual numbers of people in each category to be less than one.

IV. ANALYSIS

A. RESULTS OF THE PC-BASED MODEL

Using the PC-based model, mental category distributions for 3,074 CONUS counties for 1990-2010 were estimated. The Woods and Poole population estimates (POPEST) and formulas to calculate the estimated number of people in each mental category were entered into the spreadsheet. This process yielded the county-level population estimates by mental category (CATEST). Appendix B explains the spreadsheet format and formulas. Demographic statistics (used as input data to the PC-based model) for CONUS and selected counties for 1990 are presented in Table XI.

Table XI indicates great variation among counties in the demographic characteristics that underlie the CATEST. For example, Suffolk, NY, a predominately White county, has a smaller proportion of people in poverty and more years of parents' education for all races than the CONUS average. On the other hand, Bronx, NY, where Blacks and Hispanics make up the majority of the population, has a larger proportion of poor people and lower parental education for all races than CONUS. Boulder, CO, where 92 percent of the population are Whites, has lower proportions of poor people for minorities, and higher parents' education for all races than the CONUS

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average. Cameron, TX, a predominately Hispanic county with almost no Black population, has a higher proportion of poor people and lower parental education than CONUS.

Table XI. DEMOGRAPHIC STATISTICS FOR CONUS AND SELECTED COUNTIES, 1990

Data Field	Suffolk NY	Boulder CO	CONUS	Bronx NY	Cameron TX
TRES	49,453	10,521	9,151,971	49,739	10,796
WRES	41,282	9,712	6,892,594	12,318	2,230
BRES	4,191	156	1,312,071	19,154	2
HRES	3,980	653	947,306	18,267	8,564
WSES	5.0	9.0	9.0	13.0	30.0
BSES	17.0	10.0	27.6	46.0	18.0
HSES	12.0	15.0	22.9	41.0	38.0
WPED	12.4	14.0	12.1	10.6	9.9
BPED	11.4	13.7	10.6	11.0	10.0
HPED	11.0	11.7	9.5	9.0	8.0
SW	0.0	1.0	0.54	0.0	1.0

Source: Woods and Poole 1990 population estimates.
Note: T=total, W=white, B=black, H=hispanic, RES=resident youth population, SES=percent of population in poverty, PED=parents' education in years, SW=proportion of population in the South-West.

Using the demographic statistics in Table XI as input data to the PC-based model, the output (mental category distributions) for CONUS and selected counties was obtained and presented in Table XII. Counties which had lower proportions of poor people and higher parents' education than

the CONUS average had higher percentages of their resident 17-
21 year-old males in HQ QMA and HITEC QMA than CONUS.

Table XII. MENTAL CATEGORY DISTRIBUTIONS OF 17-21 YEAR-OLD
MALES IN CONUS AND SELECTED COUNTIES, 1990

POPULA-TION	Suffolk NY	Boulder CO	CONUS	Bronx NY	Cameron TX
RES	49,4532	10,521	9,151,971	49,739	10,796
MA	26,254 53.1 %	6,708 63.8 %	4,450,117 48.6 %	21,042 42.3 %	3,983 36.9 %
HQ QMA	15,942 32.2 %	4,394 41.8 %	2,375,586 26.0 %	6,931 13.9 %	1,306 12.1 %
HITEC QMA	11,071 22.4 %	3,136 29.8 %	1,584,687 17.3 %	3,836 7.7 %	701 6.5 %

Note: RES=resident youth population, MA=military
available population, HQ QMA=high quality qualified
military available population (CAT1 + CAT2).

As presented in Table XII, in Suffolk, NY, 32.2 percent of
the resident youth population are HQ QMA, and 22.4 percent are
HITEC QMA. Both percentages are larger than corresponding
percentages (26.0 and 17.3 percent) for CONUS. In Boulder, CO,
qualification rates for HQ and HITEC are even higher than
Suffolk, NY: 41.8 and 29.8 percent respectively. On the other
hand, Bronx, NY, and Cameron, TX, have lower qualification
rates for both HQ and HITEC than the CONUS average as a result
of their lower parents' education and higher poverty rates
than CONUS.

Regional variation in demographic characteristics, as
exemplified in Table XI, has led to great variation in mental

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qualification for HQ and HITEC, as shown in Table XII. The PC-based model, which estimated the mental composition of regional recruit markets given regional demographic characteristics has captured the variation in the mental quality of regional recruit markets.

B. VALIDITY OF THE PC-BASED MODEL

The validity of the PC-based model was assessed by comparing the 1990 CATEST (Category Estimates) and the 1990 ACTAC (Actual Accessions). Quattro Pro Version 4.0 (QPRO) was used for this procedure.

Counties that were not in both the 1990 POPEST (Population Estimates) and the 1990 ACTAC were discarded. The 1990 POPEST had 3,074 CONUS counties whereas the 1990 ACTAC included 3,047 counties both in the CONUS and not in CONUS. Some counties had no actual enlistment in 1990. After discarding nonmatching counties, there were 2,988 CONUS counties used in this validation procedure. About 1 percent of the 1990 ACTAC data for each data field, and about 2 percent of the 1990 POPEST data for each data field were lost in this matching process. The largest proportion of the lost data was 5 percent of the Black population in the 1990 POPEST.

With the 1990 ACTAC and the 1990 POPEST on the same spreadsheet, counties were rank-ordered by the 1990 estimate of the total military available (MA) population. Bundles of counties such as the top 100, top 200,..., top 1,000, top

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2,000, and all 2,988 were examined for geographic variation in the MA population by race and mental category in the 1990 CATEST, and in actual accessions by race, mental category and branch of service in the 1990 ACTAC. The TOP 1,000 counties accounted for more than 90 percent of all population segments. For this reason, relationships between estimates and actual data for the TOP 1,000 counties were tne focus of the validity evaluation.

The relationships between estimates and actual data for each population segment by race and mental category (except CAT4) for the TOP 1,000 counties were investigated using a simple linear regression procedure. The relationships for CAT4 were excluded because only a very small portion (0.5 percent) of the MA population in this category was actually recruited. The simple linear regression model is:

$$Y_i = a + bX_i + e_i$$

where Y is the dependent variable, X is the only explanatory variable, a and b are parameters and e is a random error term. The regression R-squared which is a measure of the goodness of fit for the bivariate model is also the square of the coefficient of correlation between X and Y in the simple bivariate regression model (Pindyck and Rubinfeld, 1991). The R-squared values for regressions conducted to investigate relationships between estimates and actual data are presented in Table XIII.

Table XIII. CORRELATIONS BETWEEN 1990 ACTUAL ACCESSIONS
AND ESTIMATED MENTAL QUALITY MARKET SEGMENTS IN TOP 1,000
COUNTIES

(Y) Actual Accessions	(X) Estimated Population	R-squared of regression for Total/White/Black/Hispanic
ALL	ALL MA	.83 / .78 / .88 / .81
CAT1	CAT1 QMA	.74 / .71 / .81 / .64
CAT2	CAT2 QMA	.84 / .79 / .85 / .81
CAT3	CAT3 QMA	.82 / .78 / .80 / .86

Note: Parameter estimates for X for all regressions
are significant at .01.

The simple linear regression results, as shown in Table
XIII, indicated that there was a strong correlation between
mental category estimates and actual accessions in the
corresponding categories. The correlation coefficients between
CAT1 actual accessions and CAT1 QMA varied between 0.8 (square
root of 0.64) and 0.9 (square root of 0.81) across races. For
CAT2, they were higher than for CAT1, varying between 0.89 and
.92 across races.

The fact that 83 percent of the variation in the total
actual accessions was explained by the total CONUS MA
population (and 78 percent, 88 percent, and 81 percent of the
variation for White, Black, and Hispanic subgroups,
respectively) supported the reliability of the W&P data.

The validity of the PC-based model was assessed in the
'big picture', i.e., the total estimated MA population versus

total actual accessions in CONUS for 1990. Estimated population segments by race and mental aptitude were compared to actual accessions to the Services from corresponding population segments. Correlation coefficients (found by taking square root of the R-squared of regression in Table XIII) between the population segment estimates and the actual accessions from corresponding segments were fairly high, ranging from 0.8 to 0.94. This close relationship between the estimates and the actual accessions in the 'big picture' supported the validity of the PC-based model and the mainframe model underlying it.

The real power and primary use of the PC-based model lie in estimating variation in the size and mental quality of regional recruit markets. The PC-based model, validated in the 'big picture', could now serve as a tool for evaluating geographic variation in the 1990 actual accessions by race, mental aptitude, and branch of service.

Frequency analysis of the data in the 1990 ACTAC and the 1990 CATEST showed the extent to which the actual recruitment of the Services reflected geographic variation in recruit market potential. As shown in Tables XIV through XVI, the proportions of the MA population and the actual accessions contained in the TOP 100, 500, and 1000 counties indicated that recruitment by the Services penetrated the less populated counties at a higher rate than the more populated counties.

Table XIV. 1990 ACTUAL ACCESSIONS, ESTIMATED MILITARY
AVAILABLE POPULATION AND UTILIZATION OF RECRUIT MARKET
POTENTIAL BY RACE IN TOP 100, 500, AND 1,000 COUNTIES

Population Segment		n	TOP 100	TOP 500	TOP 1,000
TOTAL	ACC	157,556	33.0 %	65.9 %	82.0 %
	MA	4,352,930	45.7 %	78.7 %	89.7 %
	IMPU	100.0	72.2	83.7	91.4
WHITE	ACC	117,522	27.6 %	62.5 %	80.7 %
	MA	3,514,197	41.0 %	76.6 %	88.8 %
	IMPU	100.0	67.3	81.6	90.8
BLACK	ACC	29,286	45.3 %	73.3 %	84.2 %
	MA	454,941	60.3 %	84.4 %	91.8 %
	IMPU	100.0	75.2	86.8	91.7
HISP.	ACC	10,748	58.3 %	83.1 %	90.2 %
	MA	383,792	71.2 %	91.1 %	95.7 %
	IMPU	100.0	81.8	91.2	94.3

Note: ACC=Actual Accessions, MA=estimated Military
Available population, n=number of people in population
segment, IMPU=Index of Market Potential Utilization.

The TOP 100 counties contained 45.7 percent of the MA
population while only 33.0 percent of recruits came from these
counties. This could be due to the Services acquiring fewer
recruits than what they could actually have acquired in the
TOP 100 counties. Alternatively, interest may be larger in the
smaller counties than in the larger counties.

An index of market potential utilization (IMPU) was
constructed to assess how the recruitment pattern of the
Services matched the geographic distribution pattern of
various population segments in CONUS. For each population
segment, the total number of accessions in all 2,988 CONUS

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counties was divided by the total estimated qualified military available population in CONUS. A similar ratio of actual/estimate for the same population segment for each county was computed and compared to the actual/estimate ratio for CONUS. Thus, the index of market potential utilization is:

$$IMPU_{ab} = 100 \times [(ACC_{ab} / QMA_{ab}) / (ACC_{totb} / QMA_{totb})]$$

where a is the county, and b is the population segment by race and/or mental category, ACC is actual accessions, and QMA is the estimated qualified military available population, and tot indicates all 2,988 CONUS counties. Table XIV gives IMPUs for the TOP 100, 500, and 1000 counties.

An index value smaller than 100 indicates that the actual Service accessions relative to the estimated QMA market in the county have been smaller than the national average of actual accessions to the estimated QMA market.

Table XIV revealed that a racial group which had a large portion of its MA population in any county bundle also had a large portion of its accessions in that county bundle. The TOP 100 counties had 71.2 percent of Hispanics as opposed to 60.3 percent of Blacks, and 41.0 percent of Whites, when the MA population was considered. Following the same rank order, 58.3 percent of Hispanic accessions, 45.3 percent of Black accessions, and 27.6 percent of White accessions came from the TOP 100 counties. Similar concentration patterns were observed in the TOP 500 and 1,000 counties but with smaller differences than in the TOP 100 counties.

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Table XV. 1990 ACTUAL ACCESSIONS, ESTIMATED QUALIFIED MILITARY AVAILABLE POPULATION AND UTILIZATION OF MARKET POTENTIAL BY MENTAL CATEGORY IN TOP 100, 500, AND 1,000 COUNTIES

Mental Category		n	TOP 100	TOP 500	TOP 1,000
CAT1	ACC	62,201	30.3 %	65.6 %	82.5 %
	QMA	1,553,921	44.5 %	80.3 %	91.0 %
	IMPU	100.0	68.1	81.7	90.6
CAT2	ACC	42,646	35.8 %	68.0 %	83.6 %
	QMA	774,640	45.0 %	78.7 %	89.9 %
	IMPU	100.0	79.6	86.4	92.9
CAT3	ACC	46,422	33.6 %	64.5 %	80.3 %
	QMA	841,833	45.0 %	77.5 %	89.0 %
	IMPU	100.0	74.8	83.3	90.1

Note: ACC=Actual Accessions, QMA=estimated Qualified Military Available population, n=number of people, and IMPU=Index of Market Potential Utilization.

Another comparison, made for the estimates and actual accessions by mental category and presented in Table XV, revealed that the IMPU for CAT1 was the lowest of all mental categories. The TOP 100 counties contained 44.5 percent of CAT1 QMA, while only 30.3 percent of accessions in this category took place here, yielding an IMPU of 68.1 for the TOP 100 counties. For CAT2, IMPUs were higher than for CAT1 or CAT3 for all county bundles.

Table XVI shows how the Services have differed regarding individual market utilization rates. The TOP 100 counties contained 45.7 percent of the MA in CONUS. The Army, Navy, Air Force, and Marine Corps acquired 32.4, 33.8, 27.9, and 37.0 percent of all their recruits, respectively, from these

Table XVI. 1990 ACTUAL ACCESSIONS, ESTIMATED MILITARY
AVAILABLE POPULATION AND UTILIZATION OF RECRUIT MARKET
POTENTIAL BY BRANCH OF SERVICE IN TOP 100, 500, AND 1,000
COUNTIES

Service		n	TOP 100	TOP 500	TOP 1,000
ALL	ACC	157,556	33.0 %	65.9 %	82.0 %
SERV-	MA	4,352,930	45.7 %	78.7 %	89.7 %
ICES	IMPU	100.0	72.2	83.7	91.4
ARMY	ACC	55,340	32.4 %	64.7 %	80.9 %
	MA	1,528,924	45.7 %	78.7 %	89.7 %
	IMPU	100.0	71.0	82.2	90.2
NAVY	ACC	51,209	33.8 %	66.6 %	82.8 %
	MA	1,414,793	45.7 %	78.7 %	89.7 %
	IMPU	100.0	74.0	84.7	92.3
AIR	ACC	23,739	27.9 %	61.8 %	80.1 %
FORCE	MA	655,857	45.7 %	78.7 %	89.7 %
	IMPU	100.0	61.1	78.5	89.2
MARINE	ACC	27,268	37.0 %	70.4 %	84.4 %
CORPS	MA	753,356	45.7 %	78.7 %	89.7 %
	IMPU	100.0	81.1	89.5	94.1

Note: (1) ACC=Actual Accessions, QMA=estimated
Qualified Military Available population, n=number of
people, IMPU=Index of Market Potential Utilization.

counties.

Two largest Services, the Army and the Navy, had utilized
the recruit market potential at rates comparable to the
average of all Services. The Air Force had the lowest IMPUs
across county bundles among the Services, while the Marine
Corps had the highest. Perhaps the Marine Corps is taking more
effectively into account the geographic variation in the
distribution of military available population when allocating
its recruiting resources.

The IMPU, if adjusted to account for interest in joining
the military, might be a better measure of how actual

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recruitment has matched recruit market potential. Future research should focus on regional variation in interest in joining the military, and improve the usability of the IMPU by inc ding interest in the military in its calculation.

The PC-based model showed clearly the variation in mental quality of regional recruit markets. Two counties of comparable size with respect to RES population might have greatly different proportions of HQ and HITEC youth. This variation in mental quality calls for devoting differential quantities of recruiting resources to regional recruiting markets. Allocating recruiting resources and concentrating recruiting efforts in accordance with geographic variation in the mental qualification rates of the military available population should bring about greater recruiting success in a more cost-effective manner.

C. MALE RECRUIT MARKET SHRINKAGE: PROJECTIONS THROUGH 2010

Recruiting success in the future depends on accurately estimating the changes in the size and mental composition of regional recruit markets and taking appropriate measures. Using the PC-based model and the W&P population estimates for 1995, 2000, 2005, and 2010, changes in the size and mental category distribution of the male recruit market for the next 20 years were estimated. Table XVII provides the size distribution and percentage changes for the military available population by mental category through 2010.

The total male 17-21 year-old resident population is expected to decline to 8.4 million by 1995, a 7.9 percent decrease from 9.2 million in 1990. In the next five-year period it will increase by 13 percent to reach 9.5 million, a level slightly higher than that of 1990. The 2000-2005 period will witness a 7.3 percent increase as the resident population reaches 10.2 million. Then, in the 2005-2010 period, this population segment will be relatively stable at 10.3 million, increasing only 1 percent from the previous period. The military available population, HQ QMA (CAT1 plus CAT2) population, and HITEC QMA population will have somewhat different growth patterns than the resident population.

Over the 1990-2010 period, the RES population will increase by 12.7 percent, while the MA population will increase by 13.2 percent, a half percentage point more than the RES population. HQ QMA and HITEC QMA will increase by 8.7 and 7.2 percent respectively. Slower growth of HQ QMA and HITEC QMA than MA population in fact shows that HQ QMA and HITEC QMA will decline with respect to MA population. Both of them will comprise a smaller proportion of MA in the future than they do today, as a result of the expected decline in the quality of the youth population as discussed in Ch II.a.

The changes in the HITEC QMA population will be unfavorable to the military as it will show a larger decrease during the 1990-1995 period and smaller increases in the subsequent two five-year periods than resident population and

Table XVII. CHANGES IN MALE RECRUIT MARKET BY MENTAL
CATEGORY: PROJECTIONS TO 2010

Pop Segment		1990	1995	2000	2005	2010	change in 1990-2010
RES	n	9,152	8,426	9,523	10,214	10,314	
	Δ	----	-7.9%	13.0 %	7.3 %	1.0 %	12.7 %
MA	n	4,450	4,068	4,635	4,988	5,039	
	Δ	----	-8.6 %	13.9 %	7.6 %	1.0 %	13.2 %
CAT1	n	1,585	1,426	1,606	1,701	1,698	
	Δ	----	-10.0 %	12.7 %	5.9 %	0.0 %	7.1 %
CAT2	n	791	721	818	876	883	
	Δ	----	-8.9 %	13.4 %	7.1 %	1.0 %	11.6 %
CAT3	n	860	790	899	969	981	
	Δ	----	-8.2 %	13.8 %	7.8 %	1.2 %	14.1 %
CAT4	n	1,214	1,132	1,312	1,442	1,477	
	Δ	----	-6.8 %	15.9 %	9.9 %	2.4 %	21.7 %

Note: n=number of people in **thousands**, and
Δ=change with respect to **previous period**.

MA population, and no increase in the 2005-2010 period.

Figure 1 shows graphically how the male recruit market will change in the 1990-2010 period. Changes in the RES, MA, HQ QMA, and HITEC QMA populations are included. The growth in RES population over the 1995-2010 period belies the much more modest increases in HQ QMA and HITEC QMA. The widening gap between MA and HQ QMA/HITEC QMA is evident as well.

The shrinkage of the high quality and hitec markets relative to the slow growing youth population may present serious recruiting issues over this extended time frame.
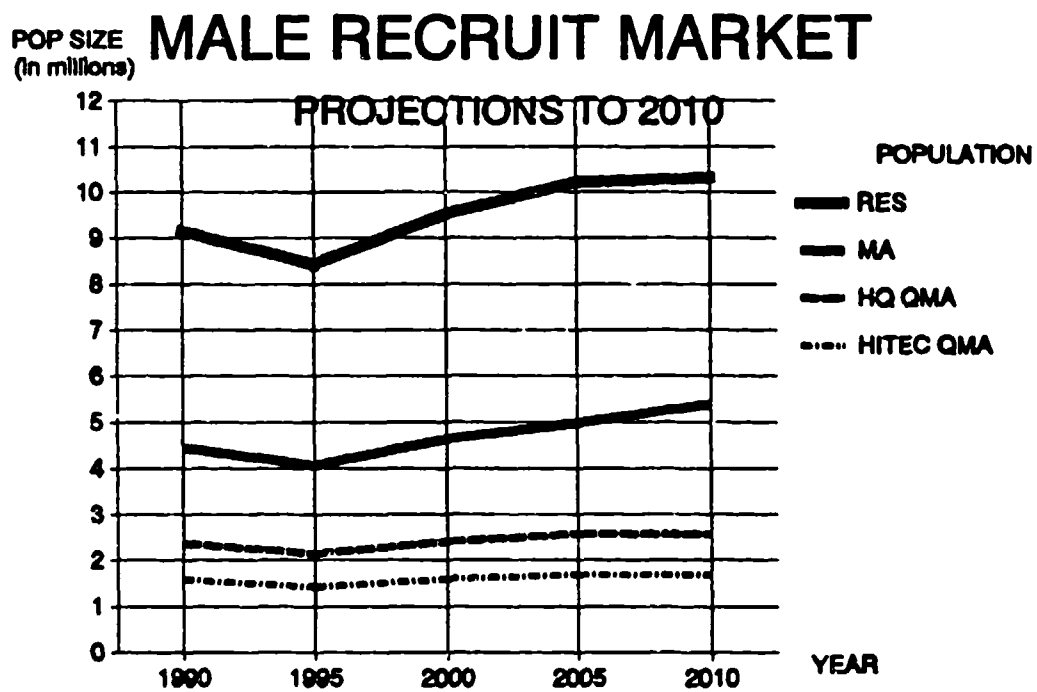
POP SIZE
(in millions)

MALE RECRUIT MARKET

PROJECTIONS TO 2010

POPULATION

RES

MA

HQ QMA

HITEC QMA

YEAR

Figure 1. Changes In Male Recruit Market: Projection To 2010.

V. CONCLUSION AND RECOMMENDATIONS

Three conclusions can be drawn from this thesis: (1) a PC-based model for estimating the size and mental aptitude composition of regional recruit markets can be developed, (2) a nationwide county-level database that contains estimates for the size and composition of the recruit market for each county for the future can be developed, and (3) resultant models that estimate the size and mental composition of regional recruit markets are valid.

The PC-based model developed in this thesis is an application tool for the utilization of results of previous research on estimating regional recruit markets. Previous research used logistic regression models that required mainframe computers for estimating the size and mental composition of regional recruit markets given demographic characteristics. These models were complicated, and moreover, not readily available to recruiting managers and recruiters. The PC-based model uses a commercially available spreadsheet software. It can be easily used by manpower managers, planners and recruiters.

The PC-based model and the econometric mental quality estimating equations underlying it were validated by comparing the estimated mental aptitude composition of regional recruit markets for 1990 and the actual accessions from these markets

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to the Services in 1990. The PC-based model appeared to have fairly good predictive power.

An index of market potential utilization (IMPU) was developed to evaluate how recruitment by the military branch matched variation in mental quality of regional markets in 1990. It showed that the Services acquired recruits from smaller regional markets at higher rates than they did from larger ones. This might imply that recruiting efforts were distributed disproportionately to the potential of regional recruit markets. Taking variation in the mental aptitude composition of regional recruit markets into account will facilitate the allocation of recruiting efforts according to market potential.

A nationwide county-level database was constructed using the PC-based model, and the W&P population estimates. The database contained the estimated size and mental composition of the MA population in each county in CONUS for 1990, 1995, 2000, 2005, and 2010. Trends in the resident, MA, HQ QMA, and HITEC QMA populations were forecast over the 1990-2010 period. In that period, the HQ QMA and HITEC QMA populations were forecast to grow more slowly than the resident youth population and military available youth population. This slow growth in HQ QMA and HITEC QMA populations is likely to make the achievement of recruiting goals more difficult.

The database, providing information on regional recruit markets such as population trends, market potential

utilization, and mental quality, allows manpower managers, planners, and recruiters to make better management decisions in resource allocation and manpower acquisition goaling. The database can be easily updated with new market population and demographic data available in the future.

An important limitation of the PC-based model, the nationwide database, and the IMPU is that they do not include interest in joining the military. Interest in the military is an important factor in the estimation of regional recruit markets. Further work incorporating interest in joining the military should be done to enhance the PC-based model and the nationwide county-level database.

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APPENDIX A. NAVY HIGHLY TECHNICAL RATINGS

GROUP	ABBR.	TITLE
I	AQ	Aviation Fire Control Technician
	AT	Aviation Electronics Technician
	AX	Aviation Antisubmarine Warfare Technician
	ET	Electronics Technician
	EW	Electronics Warfare Technician
	FC	Fire Control Technician
	IC(SUB)	Interior Communications Electrician
	STG	Sonar Technician
II	AC	Air Traffic Controller
	AE	Aviation Electrician's Mate
	AG	Aerographer's Mate
	AW	Antisubmarine Warfare Operation
	EM	Electrician's Mate
	OTA	Ocean Systems Technician (Analyst)
III	GM	Gunner's Mate
	GSE	Gas Turbine System Technician (Electrical)
	GSM	Gas Turbine System Technician (Mechanical)
	IC	Interior Communications Electrician
IV	CTI	Cryptologic Technician (Interpretive)

Note: Some ratings are currently closed to women. These are AQ, EW, FC, IC(SUB), STG, AW, GM, GSE, GSM.

APPENDIX B. GENERAL SPREADSHEET FORMAT AND FORMULAS FOR OBTAINING MENTAL CATEGORY ESTIMATES FROM POPULATION ESTIMATES

The field names were entered as column headings at 10th row, columns A-AG, and data for each county were entered in a row beginning from the 11th row.

Headings for county identifications, demographic statistics and variable values by race were placed at 10th row, columns A through Q.

At 5th row, above the demographic statistics and variable values, 'shift parameters for creating scenarios' were entered and hard-wired to 'cell formulas' at 11th row, columns R-AG.

Headings for estimated population s -ments by race and mental category were placed at 10th row, columns R through AG.

Parameter estimates from the "multinomial logistic regression model' were placed at rows 5th-7th, columns W-AC, and hard-wired to 'cell formulas' at 11th row, columns R-AG.

The 'cell formulas' to calculate the number of people in each mental category by race were entered at columns R through AG beginning at the 11th row.

1. Column Headings

Column	Data Field	Description of the Data
A	FIPS	Five-digit FIPS code for the county
B	COUNTY	County name, and State abbreviation
C	TRESYR	Total resident youth population, year
D	WRESYR	White ....
E	BRESYR	Black.................................
F	HRESYR	Hispanic.................................
G	TMAYR	Total military available population, year
H	WMAYR	White.................................
I	BMAYR	Black.................................
J	HMAYR	Hispanic.................................
K	WSES	White socioeconomic status (percent poor)
L	BSES	Black.................................
M	HSES	Hispanic.................................
N	WPED	White parents' education (years of school)
O	BPED	Black.................................
P	HPED	Hispanic.................................
Q	SW	Whether the county is in the 'South-West'
R	T1QMAYR	Total CAT1 QMA population, year
S	T2QMAYR	......CAT2.....................
T	T3QMAYR	......CAT3.....................
U	T4QMAYR	......CAT4.....................
V	W1QMAYR	White CAT1.....................
W	W2QMAYR	......CAT2.....................

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X     W3QMAYR        ......CAT3......................
Y     W4QMAYR        ......CAT4......................
Z     B1QMAYR        Black CAT1......................
AA    B2QMAYR        ......CAT2......................
AB    B3QMAYR        ......CAT3......................
AC    B4QMAYR        ......CAT4......................
AD    H1QMAYR        Hispanic CAT1...................
AE    H2QMAYR        .........CAT2...................
AF    H3QMAYR        .........CAT3...................
AG    H4QMAYR        .........CAT4...................
```

2. Cell Formulas (in QPRO language)

Location Formula

Location	Formula
R11	+V11+Z11+AD11
S11	+W11+AA11+AE11
T11	+X11+AB11+AF11
U11	+Y11+AC11+AG11
V11	(H5*$H11)*(1/(1+@EXP(-($W$5+($Z$5*$K$5*$K11) +(AA5*N$5*$N11)+(AB5*N5*N5*$N11*$N11) +(AC5*$Q11)))))
W11	(H5*$H11)*(1/(1+@EXP(-($X$5+($Z$5*$K$5*$K11) +(AA5*N$5*$N11)+(AB5*N5*N5*$N11*$N11) +(AC5*$Q11)))))-$V11
X11	(H5*$H11)*(1/(1+@EXP(-($Y$5+($Z$5*$K$5*$K11) +(AA5*N$5*$N11)+(AB5*N5*N5*$N11*$N11) +(AC5*$Q11)))))-$V11-$W11
Y11	(H5*$H11)-$V11-$W11-$X11
Z11	(I5*$I11)*(1/(1+@EXP(-($W$6+($Z$6*$L$5*$L11) +(AA6*O$5*$O11)+(AB6*O5*O5*$O11*$O11; +(AC6*$Q11)))))
AA11	(I5*$I11)*(1/(1+@EXP(-($X$6+($Z$6*$L$5*$L11) +(AA6*O$5*$O11)+(AB6*O5*O5*$O11*$O11) +(AC6*$Q11)))))-$Z11
AB11	(I5*$I11)*(1/(1+@EXP(-($Y$6+($Z$6*$L$5*$L11) +(AA6*O$5*$O11)+(AB6*O5*O5*$O11*$O11) +(AC6*$Q11)))))-$Z11-$AA11
AC11	(I5*$I11)-$Z11-$AA11-$AB11
AD11	(J5*$J11)*(1/(1+@EXP(-($W$7+($Z$7*$M$5*$M11) +(AA7*P$5*$P11)+(AB7*P5*P5*$P11*$P11) +(AC7*$Q11)))))
AE11	(J5*$J11)*(1/(1+@EXP(-($X$7+($Z$7*$M$5*$M11) +(AA7*P$5*$P11)+(AB7*P5*P5*$P11*$P11) +(AC7*$Q11)))))-$AD11
AF11	(J5*$J11)*(1/(1+@EXP(-($Y$7+($Z$7*$M$5*$M11) +(AA7*P$5*$P11)+(AB7*P5*P5*$P11*$P11) +(AC7*$Q11)))))-$AD11-$AE11
AG11	(J5*$J11)-$AD11-$AE11-$AF110I.

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